Rates and Work

For questions in the Quantitative Comparison format ("Quantity A" and "Quantity B" given), the answer choices are always as follows:

(A) Quantity A is greater.
(B) Quantity B is greater.
(C) The two quantities are equal.
(D) The relationship cannot be determined from the information given.

For questions followed by a numeric entry box $\boxed{}$, you are to enter your own answer in the box. For questions followed by fraction-style numeric entry boxes $\frac{\boxed{}}{\boxed{}}$, you are to enter your answer in the form of a fraction. You are not required to reduce fractions. For example, if the answer is 1/4, you may enter 25/100 or any equivalent fraction.

All numbers used are real numbers. All figures are assumed to lie in a plane unless otherwise indicated. Geometric figures are not necessarily drawn to scale. You should assume, however, that lines that appear to be straight are actually straight, points on a line are in the order shown, and all geometric objects are in the relative positions shown. Coordinate systems, such as *xy*-planes and number lines, as well as graphical data presentations such as bar charts, circle graphs, and line graphs, *are* drawn to scale. A symbol that appears more than once in a question has the same meaning throughout the question.

1. Roger took 2 hours to walk from his home to a store 3 miles away, and then returned home along the same path. If Roger's average rate for the round trip was 2 miles per hour, at what rate, in miles per hour, did Roger return home?

(A) $\frac{10}{3}$
(B) 3
(C) $\frac{5}{2}$
(D) 2
(E) 1

2. Running on a 10-mile loop in the same direction, Sue ran at a constant rate of 8 miles per hour and Rob ran at a constant rate of 6 miles per hour. If they began running at the same point on the loop, how many hours later did Sue complete exactly 1 more lap than Rob?

(A) 3

(B) 4

(C) 5
(D) 6
(E) 7

3.Svetlana ran the first 5 kilom eters of a 10-kilom eter race at a constant rate of 12 kilom eters per hour.If she com pleted the entire 10-kilom eter race in 55 m inutes,at w hat constant rate did she run the last 5 kilom eters of the race,in kilom eters per hour?

(A) 15
(B) 12
(C) 11
(D) 10
(E) 8

4.A standard m achine fills paint cans at a rate of 1 gallon every 4 m inutes.A deluxe m achine fills gallons of paint at tw ice the rate of a standard m achine.H ow m any hours w ill it take a standard m achine and a deluxe m achine, w orking together,to fill 135 gallons of paint?

(A) 1
(B) 1.5
(C) 2
(D) 2.5
(E) 3

5.W endy builds a birdhouse in 15 hours and M ichael builds an identical birdhouse in 10 hours.H ow m any hours w ill it take W endy and M ichael,w orking together at their respective constant rates,to build a birdhouse? (A ssum e that they can w ork on the sam e birdhouse w ithout changing each other's w ork rate.)

(A) 5
(B) 6
(C) 7
(D) 8
(E) 9

6.M achine A ,w hich produces 15 golf clubs per hour,fills a production lot in 6 hours.M achine B fills the sam e production lot in 1.5 hours.H ow m any golf clubs does M achine B produce per hour?

golf clubs per hour

7.D avis drove from A m ityville to B eteltow n at 50 m iles per hour,and returned by the sam e route at 60 m iles per hour.

Quantity A	Quantity B
D avis' average speed for the round trip,in m iles per hour	55

8.If a turtle traveled $\frac{1}{30}$ of a m ile in 5 m inutes,w hat w as its speed in m iles per hour?

(A) 0.02
(B) $0.1\overline{6}$

(C) 0.4
(D) 0.6
(E) 2.5

9. Akilah traveled at a rate of x miles per hour for $2x$ hours

Quantity A	**Quantity B**
The number of miles Akilah traveled	$3x$

10. Claudette travels the first $\frac{2}{3}$ of a 60-mile trip at 20 miles per hour (mph) and the remainder of the trip at 30 mph. How many minutes later would she have arrived if she had completed the entire trip at 20 mph?

$\boxed{}$ minutes

11. Rajesh traveled from home to school at 30 miles per hour, then returned home at 40 miles per hour to retrieve a forgotten item, and finally returned back to school at 60 miles per hour, all along the same route. What was his average speed for the entire trip, in miles per hour?

(A) 32
(B) 36
(C) 40
(D) 45
(E) 47

12. Jack traveled the first 75% of an 80-mile trip at 45 miles per hour and the remainder at 30 miles per hour. What was Jack's average speed for the entire 80-mile trip, in miles per hour?

(A) 37.5
(B) 38.25
(C) 40
(D) 41.25
(E) 42.5

13. Lamont traveled 80 miles in 2.5 hours, at a constant rate. He then decreased his speed by 25% and traveled 120 additional miles at the new constant rate. How many hours did the entire journey take?

(A) 6.25
(B) 7.5
(C) 8.75
(D) 10
(E) 11.25

14. Twelve workers pack boxes at a constant rate of 60 boxes in 9 minutes. How many minutes would it take 27 workers to pack 180 boxes, if all workers work at the same constant rate?

(A) 12
(B) 13
(C) 14
(D) 15
(E) 16

15. Four editors can proofread 4 documents in 4 hours. How many editors would be required to proofread 80 documents in 2 hours, if all editors proofread all documents at the same constant rate?

(A) 120
(B) 130
(C) 140
(D) 150
(E) 160

16. To service a single device in 12 seconds, 700 nanorobots are required, with all nanorobots working at the same constant rate. How many hours would it take for a single nanorobot to service 12 devices?

(A) 7/3
(B) 28
(C) 108
(D) 1,008
(E) 1,680

17. Working at a constant rate, Sarita answered *x* verbal test questions in 3 hours. Separately, she solved math problems at a constant rate of *y* math problems every 30 minutes.

Quantity A	**Quantity B**
The number of verbal test questions Sarita answered in 1 hour	The number of math problems Sarita solved in 1 hour

18. If 45 people built $\frac{1}{2}$ of a pyramid in 288 days, how many days did it take 65 people to build the next $\frac{1}{6}$ the pyramid, rounded to the nearest integer, assuming each person works at the same constant rate?

$\boxed{}$ days

19. A machine purifies 100 cubic feet (ft^3) of water in 4 minutes. How many minutes will it take the machine to purify the contents of a 15 foot × 15 foot × 10 foot tank that is $\frac{1}{2}$ of full of water?

(A) 20
(B) 30
(C) 45
(D) 60
(E) 75

20. If a baker made 60 pies in the first 5 hours of his workday, by how many pies per hour did he increase his rate in the last 3 hours of the workday in order to complete 150 pies in the entire 8-hour period?

(A) 12
(B) 14
(C) 16
(D) 18
(E) 20

21.A stockbroker w orked 10 hours a day on M onday,W ednesday,and Friday,11 hours a day on Tuesday and Thursday,and 8 hours on Saturday.She earned $600 each w eekday and $300 on Saturday.

Q uantity A	Q uantity B
The stockbroker's average earnings,in dollars per hour,over the 6-day period.	50

22.Tw o coal carts,A and B ,started sim ultaneously from opposite ends of a 400-yard track.C art A traveled at a constant rate of 40 feet per second;C art B traveled at a constant rate of 56 feet per second.A fter how m any seconds of travel did the tw o carts collide? (1 yard = 3 feet)

(A) 75
(B) 48
(C) $23\frac{1}{3}$
(D) $12\frac{1}{2}$
(E) $4\frac{1}{6}$

23.N ine identical m achines,each w orking at the sam e constant rate,can stitch 27 jerseys in 4 m inutes.H ow m any m inutes w ould it take 4 such m achines to stitch 60 jerseys?

(A) 8
(B) 12
(C) 16
(D) 18
(E) 20

24.B renda w alked a 12-m ile scenic loop in 3 hours.If she then reduced her w alking speed by half,how m any hours w ould it take B renda to w alk the sam e scenic loop tw o m ore tim es?

(A) 6
(B) 8
(C) 12
(D) 18
(E) 24

25.A gang of crim inals hijacked a train heading due south.A t exactly the sam e tim e,a police car located 50 m iles north of the train started driving south tow ard the train on an adjacent roadw ay parallel to the train track.If the train traveled at a constant rate of 50 m iles per hour,and the police car traveled at a constant rate of 80 m iles per hour,how long after the hijacking did the police car catch up w ith the train?

(A) 1 hour
(B) 1 hour and 20 m inutes
(C) 1 hour and 40 m inutes
(D) 2 hours
(E) 2 hours and 20 m inutes

26.Each w orking at a constant rate,R achel assem bles a brochure every 10 m inutes and Terry assem bles a brochure every 8 m inutes.

Q uantity A	Q uantity B
The num ber of m inutes it w ill take R achel and Terry,w orking together,to assem ble 9 brochures	40

27.W ith 4 identical servers w orking at a constant rate,a new Internet search provider processes 9,600 search requests per hour.If the search provider adds 2 m ore identical servers,and server w ork rate never varies,the search provider can process 216,000 search requests in how m any hours?

(A) 15
(B) 16
(C) 18
(D) 20
(E) 24

28.A pipe siphons ink from an 800-liter drum at a rate of *r* liters per m inute.If tw o such pipes w ere used,the drum could be em ptied 100 m inutes faster than w hen one pipe is used.

Q uantity A	Q uantity B
r	5

29.If Sabrina can assem ble a tank in 8 hours,and Janis can assem ble a tank in 13 hours,then Sabrina and Janis w orking together at their constant respective rates can assem ble a tank in approxim ately how m any hours?

(A) 21
(B) 18
(C) 7
(D) 5
(E) 2

30.Etienne began to eat 20 cookies at exactly the sam e tim e Jacques began m aking m ore cookies,one at a tim e,at a constant rate of 16 cookies per hour.If Etienne ate 20 cookies per hour,after how m any hours w ere there no cookies?

31.Phil collects virtual gold in an online com puter gam e,and then sells the virtual gold for real dollars.A fter playing 10 hours a day for 6 days,he collected 540,000 gold pieces.If he im m ediately sold this virtual gold at a rate of $1 per 1,000 gold pieces,w hat w ere his average earnings per hour,in real dollars?

(A) 5
(B) 6
(C) 7
(D) 8
(E) 9

32.A fter com pleting a speed training,A lyosha translates R ussian literature into English at a rate of 10 m ore than tw ice as m any w ords per hour as he w as able to translate before the training.If he w as previously able to translate 10 w ords per m inute,how m any w ords can he now translate in an hour?

(A) 30

(B) 70
(C) 610
(D) 1,210
(E) 1,800

33.Jenny takes 3 hours to sand a picnic table;Laila can do the sam e job in $\frac{1}{2}$ hour.W orking together at their respective constant rates,Jenny and Laila can sand a picnic table in how m any hours?

(A) 1/6
(B) 2/9
(C) 1/3
(D) 3/7
(E) 5/6

34.

O ne w orker strings 2 violins in 3 m inutes.A ll w orkers string violins at the sam e constant rate.

Q uantity A	**Q uantity B**
The num ber of m inutes required for 12 w orkers to string 720 violins	The num ber of violins that 5 w orkers can string in 24 m inutes

35.R iders board the Jelly C oaster in groups of 4 every 15 seconds.If there are 200 people in front of K urt in line,in approxim ately how m any m inutes w ill K urt board the Jelly C oaster?

(A) 5
(B) 8
(C) 10
(D) 13
(E) 20

36.M achines A and B both shrink-w rap C D s continuously,each w orking at a constant rate,but M achine B w orks 50% faster than M achine A .If M achine B shrink-w raps 48,000 m ore C D s in a 24-hour period than M achine A does, w hat is M achine A 's shrink-w rapping rate in C D s per hour?

(A) 4,000
(B) 6,000
(C) 8,000
(D) 12,000
(E) 16,000

37.A team of 8 chefs produce 3,200 tarts in 5 days.A ll chefs produce tarts at the sam e constant rate.

Q uantity A	**Q uantity B**
The num ber of chefs needed to produce 3,600 tarts in 3 days	The num ber of days that 4 chefs need to produce 4,800 tarts

38.W orking together at their respective constant rates,robot A and robot B polish 88 pounds of gem stones in 6 m inutes.If robot A 's rate of polishing is 3/5 that of robot B ,how m any m inutes w ould it take robot A alone to polish 165 pounds of gem stones?

(A) 15.75
(B) 18
(C) 18.75
(D) 27.5
(E) 30

39.C ar A started driving north from point *X* ,traveling at a constant rate of 40 m iles per hour.O ne hour later,car B started driving north from point *X* at a constant rate of 30 m iles per hour.N either car changed direction of travel.If each car started w ith 8 gallons of fuel,w hich is consum ed at a rate of 30 m iles per gallon,how m any m iles apart w ere the tw o cars w hen car A ran out of fuel?

(A) 30
(B) 60
(C) 90
(D) 120
(E) 150

40.A population of bacteria doubled at a constant rate,increasing from 50 to 3,200 bacteria in exactly tw o days.

<u>Q uantity A</u>	**<u>Q uantity B</u>**
Tw ice the population of bacteria after 16 m ore hours	The population of bacteria after 32 m ore hours

41.O ne robot,w orking independently at a constant rate,can assem ble a doghouse in 12 m inutes.W hat is the m axim um num ber of <u>com plete</u> doghouses that can be assem bled by 10 such identical robots,each w orking on <u>separate</u> doghouses at the sam e rate for $2\frac{1}{2}$ hours?

(A) 20
(B) 25
(C) 120
(D) 125
(E) 150

42.A sem iconductor com pany predicts that it w ill be able to double the density of transistors on its circuits (m easured in transistors per square m m) every 18 m onths.If this prediction holds true,and the com pany’s circuits currently have a density of 5 m illion transistors per square m m ,w hat w ill be the density of transistors on the com pany’s circuits,m easured in m illions of transistors per square m m ,exactly 30 years from now ?

(A) 5×2^{18}
(B) 5×2^{20}
(C) 5×2^{26}
(D) 5×2^{36}
(E) 5×2^{45}

43.W orking continuously 24 hours a day,a factory bottles Soda Q at a rate of 500 liters per second and Soda V at a rate of 300 liters per second.If tw ice as m any bottles of Soda V as of Soda Q are filled at the factory each day, w hat is the ratio of the volum e of a bottle of Soda Q to a bottle of Soda V ?

(A) 3/10
(B) 5/6
(C) 6/5
(D) 8/3
(E) 10/3

44. Working alone at their respective constant rates, Audrey can complete a certain job in 4 hours, while Ferris can do the same job in 3 hours. Audrey and Ferris worked together on the job and completed it in 2 hours, but while Audrey worked this entire time, Ferris worked for some of the time and took 3 breaks of equal length. How many minutes long was each of Ferris's breaks?

(A) 5
(B) 10
(C) 15
(D) 20
(E) 25

45. A turtle climbed to the top of a plateau at a rate of 4 miles an hour, crossed the plateau at a rate of x miles per hour, and descended the other side of the plateau at a rate of x^2 miles per hour. If each portion of the journey was equal in distance, what was the turtle's average speed for the entire trip, in terms of x?

(A) $\dfrac{2x}{x+2}$

(B) $\dfrac{(x+2)^2}{3}$

(C) $(x+2)^2$

(D) $\dfrac{4x^2}{(x+2)^2}$

(E) $\dfrac{12x^2}{(x+2)^2}$

R ates and W ork A nsw ers

1.**(B).**The average rate at w hich R oger travels is the total distance traveled divided by the total tim e spent traveling.In this case,R oger traveled 3 m iles to and 3 m iles back from a store,covering a total of 6 m iles.The average rate for the w hole trip is given as 2 m iles per hour.Solve for the total tim e,using the variable *t*:

$$\text{average rate} = \frac{\text{total distance}}{\text{total time}}$$
$$2 = \frac{6}{t}$$
$$2t = 6$$
$$t = 3$$

The total tim e that R oger spent traveling w as 3 hours.Since he took 2 hours to w alk to the store,he only took 3 - 2 = 1 hour returning from the store.R oger traveled the 3 m iles back in 1 hour,so he traveled at a rate of 3 m iles per hour on the return trip.

2.**(C).**If Sue com pleted exactly one m ore lap than R ob,she ran 10 m ore m iles than R ob.If R ob ran *d* m iles,then Sue ran *d* + 10 m iles.R ob and Sue began running at the sam e tim e,so they ran for the sam e am ount of tim e.Let *t* represent the tim e they spent running.Fill out a chart for R ob and Sue:

	D (miles)	=	R (miles/hour)	×	T (hours)
Rob	d	=	6	×	t
Sue	$d + 10$	=	8	×	t

There are tw o equations:

$d = 6t$ $\qquad$ $d + 10 = 8t$

Substitute 6*t* for *d* in the second equation,and then solve for *t*:

$6t + 10 = 8t$
$10 = 2t$
$5 = t$

3.**(D).**To calculate Svetlana's speed during the second half of the race,first calculate how long it took her to run the first half of the race.Svetlana ran the first 5 kilom eters at a constant rate of 12 kilom eters per hour.These values can be used in the *D* = *RT* form ula.

D (km)	=	R (km/hr)	×	T (hr)
5	=	12	×	t

Svetlana's time for the first part of the race is 5/12 hours, or 25 minutes.

She completed the entire 10-kilometer race in 55 minutes, so she ran the last 5 kilometers in 55 - 25 = 30 minutes, or 0.5 hours.

D (km)	=	R (km/hr)	×	T (hr)
5	=	r	×	0.5

$5 = 0.5r$
$10 = r$

Svetlana ran the second half of the race at a speed of 10 kilometers per hour.

4. **(E).** The question asks for the amount of time in hours, so re-express the work rates in gallons per hour, not gallons per minute. First, calculate the rate of the standard machine:

$$\frac{1 \text{ gallon}}{4 \text{ minutes}} \times \frac{60 \text{ minutes}}{1 \text{ hour}} = \frac{60 \text{ gallons}}{4 \text{ hours}} = 15 \text{ gallons/hour}$$

Since the deluxe machine's rate is twice the standard machine's rate, the deluxe machine can fill 15 × 2 = 30 gallons of paint per hour. Together, the machines can fill 15 + 30 = 45 gallons of paint per hour. Now apply $W = R \times T$:

$135 = 45 \times T$
$3 = T$

5. **(B).** Use two separate lines in a $W = RT$ chart, one for Wendy and one for Michael, to calculate their respective rates. Building 1 birdhouse equals doing 1 unit of work:

	W (birdhouses)	=	R (birdhouses/hour)	×	T (hours)
Wendy	1	=	R_W	×	15
Michael	1	=	R_M	×	10

Thus, Wendy's rate is 1/15 birdhouses per hour, and Michael's rate is 1/10 birdhouses per hour. Since Wendy and Michael are working together, add their rates:

	W (birdhouses)	=	R (birdhouses/hour)	×	T (hours)
Wendy + Michael	1	=	$\frac{1}{15}+\frac{1}{10}$	×	t

N ow solve for *t* by first com bining the fractions:

$$1=\left(\frac{1}{15}+\frac{1}{10}\right)t$$
$$1=\left(\frac{2}{30}+\frac{3}{30}\right)t$$
$$1=\left(\frac{5}{30}\right)t$$
$$\frac{30}{5}=t$$
$$6=t$$

6.**60 golf clubs per hour.**First,calculate the size of a production lot.M achine A w orks at a rate of 15 golf clubs per hour and com pletes a production lot in 6 hrs.Plug this inform ation into the *W* = *RT* form ula.

W (clubs)	=	R (clubs/hour)	×	T (hours)
w	=	15	×	6

w = (15 clubs per hour)(6 hours) = 90 clubs

Therefore,a production lot consists of 90 golf clubs.Since M achine B can com plete the lot in 1.5 hours,use the *W* = *RT* chart a second tim e to calculate the rate for M achine B .

W (clubs)	=	R (clubs/hour)	×	T (hours)
90	=	r	×	1.5

M ake the calculation easier by converting 1.5 hours to 3/2 hours.

$$90 = \frac{3}{2}r$$

$$\frac{2}{3} \times 90 = r$$

$$2 \times 30 = r$$

$$60 = r$$

7.(**B).**N ever take an average speed by sim ply averaging the tw o speeds (50 m ph and 60 m ph).Y ou m ust use the form ula A verage Speed = Total D istance/Total Tim e.Fortunately,for Q uantitative C om parisons,you can often sidestep actual calculations.

D avis' average speed can be thought of as an average of the speed he w as traveling at every single m om ent during his journey — for instance,say D avis w rote dow n the speed he w as going during every second he w as driving,then he averaged all the seconds.Since D avis spent m ore *tim e* going 50 m ph than going 60 m ph,the average speed w ill be closer to 50 than 60,and Q uantity B is larger.If the distances are the sam e,average speed is alw ays w eighted tow ards the *slow er* speed.

If you w ant to actually do the m ath,pick a convenient num ber for the distance betw een A m ityville and B eteltow n — for instance,300 m iles (divisible by both 50 and 60).If the distance is 300 m iles,it took D avis 6 hours to drive there at 50 m ph,and 5 hours to drive back at 60 m ph.U sing A verage Speed = Total D istance/Total Tim e (and a total distance of 600 m iles,for both parts of the journey):

A verage Speed = 600 m iles/11 hours
A verage Speed = 54.54…

Y ou w ill get the sam e result w ith any value you choose for the distance.Thus,Q uantity B is greater.

8.(**C).**The turtle traveled 1/30th of a m ile in 5 m inutes,w hich is 1/12 of an hour.U sing the *D* = *RT* form ula,solve for *r*:

D (mile)	=	R (miles/hour)	$\times$	T (hours)
$\frac{1}{30}$	=	r	$\times$	$\frac{1}{12}$

$$\frac{1}{30} = \frac{1}{12}r$$

$$\frac{12}{30} = r$$

$$0.4 = r$$

9.**(D)** U se *D* = *RT*:

D istance = $x(2x)$

D istance = $2x^2$

Which is greater, $2x^2$ or $3x$? If $x = 1$, $3x$ is greater.B ut if $x = 2$, $2x^2$ is greater.

Without inform ation about the value of x,the relationship cannot be determ ined.

10.**20 m inutes.**First,figure out how long it took C laudette to travel 60 m iles under the actual conditions.The first leg of the trip w as 2/3 of 60 m iles,or 40 m iles.To travel 40 m iles at a rate of 20 m iles per hour,C laudette spent 40/20 = 2 hours = 120 m inutes.The second leg of the trip w as the rem aining 60 - 40 = 20 m iles.To travel that distance at a rate of 30 m iles per hour,C laudette spent 20/30 = 2/3 hour = 40 m inutes.In total,C laudette traveled for 120 + 40 = 160 m inutes.

N ow consider the hypothetical trip.If C laudette had traveled the w hole distance of 60 m iles at 20 m iles per hour,the trip w ould have taken 60/20 = 3 hours = 180 m inutes.

Finally,com pare the tw o trips.The real trip took 160 m inutes,so the hypothetical trip w ould have taken 180 - 160 = 20 m inutes longer.

11.**(C).**D o not sim ply average the three speeds.Y ou w ill alw ays get the w rong answ er that w ay.To com pute the average speed for a trip,figure out the total distance and divide by the total tim e.

Pick a convenient distance from hom e to school,one that is divisible by 30,40,and 60— say 120 m iles (tough for R ajesh,but easier for you).

The first part of the journey (from hom e to school) takes 120/30 = 4 hours.The second part of the journey takes 120/40 = 3 hours.The third part of the journey takes 120/60 = 2 hours.

The total distance R ajesh travels is 120 + 120 + 120 = 360 m iles.The total tim e is 4 + 3 + 2 = 9 hours.Finally,his average speed for the entire trip w as 360/9 = 40 m iles per hour.

12.**(C).**To find the average speed,divide the total distance by the total tim e.Y ou have to figure out the tim e for each part of the journey separately.First,figure out the m iles traveled for each part of the journey.

First part: 75% of 80 m iles = $\left(\frac{3}{4}\right)(80) = 60 \text{ miles}$

Second part: 80 - 60 = 20 m iles.

N ow use $D = RT$ for each part of the journey.The tw o rates are 45 m iles per hour and 30 m iles per hour.

First part: $60 = 45t$,w hich gives $t = 4/3$ for this part
Second part: $20 = 30t$,w hich gives $t = 2/3$ hour for the second part

So the total tim e is 4/3 + 2/3 = 6/3 = 2 hours.The total distance is 80 m iles,so the average speed w as 80/2 = 40 m iles per hour.

13.**(B).**First,determ ine Lam ont's rate for the first part of the journey.Since he traveled 80 m iles in 2.5 hours,his rate w as $\frac{80}{2.5}$ m iles per hour.This fraction can be reduced: $\frac{80}{2.5}=\frac{800}{25}=\frac{8\times100}{25}=8\times4=32$ m iles per hour. N ow ,for the second part of the journey,Lam ont decreased his speed by 25% .In other w ords,his new speed w as 100% - 25% = 75% of the original speed.

N ew speed = $75\% \times 32 = \left(\frac{3}{4}\right)(32) = 24$ m iles per hour.

H e traveled 120 m iles at 24 m iles per hour,so the tim e for the second part of the journey w as 120/24 = 5 hours.

Finally,the entire journey took 2.5 + 5 = 7.5 hours.

14.**(A).**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork = Rate × Tim e* to this:

W ork = Individual Rate × N um ber of W orkers × Tim e

U se the first sentence to solve for an individual w orker's rate.Plug in the fact that 12 w orkers pack boxes at a constant rate of 60 boxes in 9 m inutes:

W ork = Individual Rate × N um ber of W orkers × Tim e

60 = (*R*)(12)(9 m inutes)

R = 5/9 boxes per m inute

In other w ords,each w orker can pack 5/9 of a box per m inute.Plug that rate back into the form ula,but use the details from the second sentence in the problem :

W ork = Individual Rate × N um ber of W orkers × Tim e
180 = (5/9)(27)(*T*)
180 = 15*T*
12 = *T*

15.**(E).**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork = Rate × Tim e* to this:

W ork = Individual Rate × N um ber of W orkers × Tim e

Solve for an individual w orker's rate,using the fact that 4 editors can proofread 4 docum ents in 4 hours:

W ork = Individual Rate × N um ber of W orkers × Tim e
4 docum ents = (*R*)(4)(4 hours)
R = 1/4 docum ent per hour

So each editor can proofread 1/4 of a docum ent per hour.

N ote that it is N O T correct to infer that if 4 editors can proofread 4 docum ents in 4 hours,then 1 editor can proofread 1 docum ent in 1 hour.(A fter all,if 4 editors can proofread 4 docum ents in 4 hours,then each editor proofreads one of the docum ents over the w hole 4 hours,not in 1 hour.)

Plug the 1/4 rate back into the form ula,but using the details from the second sentence in the problem (using *E* for the unknow n num ber of editors):

> 80 = (1/4)(*E*)(2)
> *E* = 160

160 editors are required.A lternatively,you could reason that,since it takes an editor 4 hours to proofread one docum ent,you could get 80 docum ents proofread by 80 editors in that sam e period of tim e (4 hours).To get the job done in half the tim e,you need tw ice as m any editors,or 160 of them .

16.**(B).**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork = Rate* × *Tim e* to this:

> *W ork = Individual Rate* × *N um ber of W orkers* × *Tim e*

Solve for an individual nanorobot's rate,using the fact that 700 nanorobots can service 1 device in 12 seconds.N otice that the "w ork" here is 1 device:

> *W ork = Individual Rate* × *N um ber of W orkers* × *Tim e*
> 1 device = (*R*)(700)(12 seconds)
> *R* = 1/8,400 devices per second

That is,each nanorobot can service $\frac{1}{8,400}$ of a device in 1 second.Plug that rate back into the form ula,but using the details from the second sentence in the problem :

> *W ork = Individual Rate* × *N um ber of W orkers* × *Tim e*
> 12 = (1/8,400)(1)(*T*)
> *T* = 100,800

The answ er is 100,800 seconds.D ivide by 60 to convert this tim e to 1,680 m inutes;divide by 60 again to get 28 hours.

17.**(D).**Since Sarita answ ered *x* verbal test questions in 3 hours,she answ ered *x*/3 verbal test questions in 1 hour.So Q uantity A is *x*/3.

Thirty m inutes is 1/2 an hour.If Sarita can do *y* m ath problem s in ½ an hour,then she can do 2*y* m ath problem s in an hour.So Q uantity B is 2*y*.

W ithout m ore inform ation about *x* and *y*,it cannot be determ ined w hether *x*/3 or 2*y* is a greater num ber.The correct answ er is (D).

18.**66 days.**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork* = *Rate* × *Tim e* to this:

> *W ork = Individual Rate × N um ber of W orkers × Tim e*

Solve for an individual w orker's rate,plugging in the fact that 45 people built ½ of a pyram id in 288 days:

> *W ork = Individual Rate × N um ber of W orkers × Tim e*
> 1/2 pyram id = (*R*)(45)(288 days)
> *R* = 1/25,920 pyram id per day (don't be shy about using the calculator here)

That is,each person can build $\frac{1}{25,920}$ of a pyram id in 1 day.N ow put this rate into the w ork equation,together w ith the rem aining details in the problem :

> *W ork = Individual Rate × N um ber of W orkers × Tim e*
> 1/6 = (1/25,920)(65)(*T*)
> *T* ≈ 66.46 days

R ounded to the nearest integer,the answ er is 66 days.

19.**(B).**Since the question asks for tim e,you need: the rate and the am ount of w ork.To find the rate,divide the total w ork the purifier can do by the tim e required.100 cubic feet ÷ 4 m inutes = 25 cubic feet per m inute.

N ow find the am ount of w ork required.The tank has a total volum e of (15)(15)(10) = 2,250 cubic feet,but is only 1/2 full of w ater.Thus,the volum e of w ater to be purified is 1,125 cubic feet.

Plug these num bers back into the *W = RT* form ula and solve.

> *W = RT*
> (1,125) = (25)*T*
> *T* = 1,125 ÷ 25 = 45 m inutes

20.**(D).**First identify w hat you are looking for.To find the am ount by w hich the baker's rate of pie-m aking increased,so you need both his rate for the first 5 hours and his rate in the last 3 hours.The difference is the ultim ate answ er:

> R ate for last 3 hours - R ate for first 5 hours = Increase

The rate for the first 5 hours w as 60 pies ÷ 5 hours = 12 pies per hour.

In the last 3 hours,the baker m ade 150 - 60 = 90 pies.The rate in the last 3 hours of the w orkday w as thus 90 pies ÷ 3 hours = 30 pies per hour.

N ow find the difference betw een the tw o rates of w ork:

> 30 pies per hour - 12 pies per hour = 18 pies per hour

21.**(A).**To find average earnings per hour,divide the total earnings by the total tim e (in hours).So com pute the total earnings and the total tim e.

5 w eek days × $600 =
$3,000 1 Saturday × $300 =
$300 Total earnings = $3,300

3 days × 10 hours = 30
2 days × 11 hours = 22
1 day × 8 hours =
8 Total hours = 60

The broker's average earnings per hour = $3,300 ÷ 60 = $55 per hour.Since 55 is greater than 50,Q uantity A is greater.

22.**(D).**This is a classic com bined rates problem .Since the carts are m oving directly tow ard each other,add their rates together.R em em ber that w hen tw o objects are m oving in opposite directions — either tow ard each other or aw ay from each other — add their rates to find how fast the gap is closing (or opening up).

To avoid any unit conversion trap (answ er choice (E)),do the yards-to-feet conversion up front: 400 yards × 3 ft/yard = 1,200 feet.The com bined rate of the tw o carts is 96 ft/sec.Therefore the tim e it takes for them to m eet is 1,200 feet ÷ 96 feet/second = $12\frac{1}{2}$ seconds.

	D istance	=	R ate	×	Tim e
C art A	40*t*	=	40 ft/sec	×	*t*
C art B	56*t*	=	56 ft/sec	×	*t*
C om bined R ate	1200 feet	=	96 ft/sec	×	$12\frac{1}{2}$ sec

23.**(E).**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork = Rate × Tim e* to this:

W ork = Individual Rate × N um ber of W orkers × Tim e

Solve for an individual m achine's rate,using the fact that 9 m achines can stitch 27 jerseys in 4 m inutes.

W ork = Individual Rate × N um ber of W orkers × Tim e
27 jerseys = (*R*)(9)(4 m inutes)
R = 3/4 jersey per m inute

That is,each m achine can stitch 3/4 of a jersey in 1 m inute.Plug that rate back into the form ula,but using the details from the second sentence in the problem :

W ork = Individual Rate × N um ber of W orkers × Tim e
60 = (3/4)(4)(T)

$T = 20$

24. **(C).** In this problem, you must compare an actual scenario with a hypothetical one. Start by figuring out the rate (speed) for Brenda's actual walk. Since she walked 12 miles in 3 hours, she walked at a rate of 12/3 = 4 miles per hour.

Now, in the hypothetical situation, she would walk the loop twice, for a total distance of 12 × 2 = 24 miles. Her hypothetical speed would be 1/2 of 4 miles per hour, or 2 miles per hour.

Walking 24 miles at a rate of 2 miles per hour would take Brenda 24/2 = 12 hours.

Alternatively, you might note that both of the changes— doubling the distance and halving the rate— have the same effect: Each change makes the trip take twice as long as it would have before. So the time required for this hypothetical situation is multiplied by four: 3 × 2 × 2 = 12 hours.

25. **(C).** In this "chase" problem, the two vehicles are moving in the same direction, with one chasing the other. To determine how long it will take the rear vehicle to catch up, *subtract* the rates to find out how quickly the rear vehicle is gaining on the one in front.

The police car gains on the train at a rate of 80 - 50 = 30 miles per hour. Since the police car needs to close a gap of 50 miles, plug into $D = RT$ to find the time:

$50 = 30t$

$5/3 = t$

The time it takes to catch up is 5/3 hours, or 1 hour and 40 minutes.

26. **(C).** "Cheat" off the easy quantity. In 40 minutes (from Quantity B), Rachel would assemble 40/10 = 4 brochures and Terry would assemble 40/8 = 5 brochures, for a total of 4 + 5 = 9 brochures. Thus, Quantity A is also 40, and the two quantities are equal.

27. **(A).** If the search provider adds 2 identical servers to the original 4, there are now 6 servers. Because 6/4 = 1.5, the rate at which all 6 servers work is 1.5 times the rate at which 4 servers work:

9,600 searches per hour × 1.5 = 14,400 searches per hour

Now apply this rate to the given amount of work (216,000 searches), using the $W = RT$ formula.

$216,000 = (14,400)T$

216,000 ÷ 14,400 = 15 hours

28. **(B).** Start by filling in a $W = RT$ chart with the pieces you know. Remember, two identical pipes would siphon ink at double the rate of a single pipe.

	Work (liters)	=	Rate (liters/min)	×	Time (min)
1 pipe	800	=	r	×	**800/*r***

2 pipes	800	=	2*r*	×	**800/(2*r*)**

O ne pipe does the w ork in 800/*r* m inutes,and tw o pipes do the w ork in 800/2*r* m inutes.

The questions states that “If tw o such pipes w ere used,the drum could be em ptied 100 m inutes faster than w hen one pipe is used.Express this as a skeleton equation:

Tim e for 2 pipes + 100 = Tim e for 1 pipe

(Y ou can check that you’ve w ritten this correctly by noting that the tim e for 2 pipes should be shorter,so it is necessary to add 100 to that side to m ake it equal the longer tim e for 1 pipe.)

N ow plug in expressions for the tim es and solve for *r*:

$$\frac{800}{\;} + 100 = \frac{800}{\;}$$

800 + 200*r* =
1600 200*r* = 800
r = 4

1 pipe siphons 4 liters of ink per m inute.Thus,Q uantity A equals 4,w hich is less than Q uantity B .

29.**(D).**Since Sabrina and Janis are w orking together,add their rates.Sabrina com pletes 1 tank in 8 hours,so she w orks at a rate of $\frac{1}{8}$ tank per hour.Likew ise,Janis w orks at a rate of $\frac{1}{13}$ tank per hour.N ow ,add these fractions:

$$\frac{1}{8}+\frac{1}{13}=\frac{13}{104}+\frac{8}{104}=\frac{21}{104}$$ tanks per hour,w hen w orking together

N ow plug this com bined rate into the *W* = *RT* form ula to find the tim e.Y ou m ight also notice that since the w ork is equal to 1,the tim e w ill just be the reciprocal of the rate.

Sabrina & Janis	1 tank	=	21/104 tank/hr	×	**104/21 m inutes**

A t this point,you do not need to do long division or break out the calculator! Just approxim ate: 104/21 is about 100/20 = 5.The answ er is (D).

Y ou m ight also use som e intuition to w ork the answ er choices and avoid setting up this problem at all! Y ou can im m ediately elim inate (A) and (B),since these tim es exceed either w orker’s individual tim e.A lso,since Sabrina is the faster w orker,Janis’s contribution w ill be less than Sabrina’s.The tw o together w on’t w ork tw ice as fast as Sabrina,but they w ill w ork *m ore* than tw ice as fast as Janis.Therefore,the total tim e should be m ore than half of Sabrina’s individual tim e,and less than half of Janis’s individual tim e.4 < *t* < 6.5,w hich leaves (D) as the only possible answ er.

30.**5 hours.**Etienne and Jacques w ere w orking at cross-purposes (although perhaps Etienne didn't m ind),so *subtract* their rates.U sually you add w ork rates,but this situation is just like a car chase: w hen one car (or person) gains on another,you subtract rates.

20 cookies/hour - 16 cookies/hour = 4 cookies/hour,so the quantity of cookies decreased by 4 per hour.Since Etienne began w ith a pile of 20 cookies,it took him 20/4 = 5 hours to eat all the cookies.

N ote that Etienne ate a lot m ore than 20 cookies.In 5 hours he ate 100 cookies— the initial 20,plus the 80 that Jacques m ade in the 5 hours.

31.**(E).**To solve for average earnings,fill in this form ula:

Total earnings/Total hours = A verage earnings per hour

Since the gold-dollar exchange rate is $1 per 1,000 gold pieces: Phil's real dollar earnings for the 6 days w ere 540,000/1,000 = $540.H is total tim e w orked w as 10 hours/day × 6 days = 60 hours.Therefore,his average hourly earnings w ere $540/60 = $9/hour.

32.**(D).**To find the new rate in w ords per hour,start by setting up an equation to find this value:

N ew w ords/hr = 10 + 2(O ld w ords/hr)

The old rate w as given in w ords per m inute,so convert to w ords per hours:

10 w ords/m in × 60 m in/hr = 600 w ords/hr.

N ow plug into the equation:

N ew w ords/hr = 10 + 2(600) = 1,210

N ote that you w ould not w ant to start by w orking w ith the rate per m inute.If you did so,you'd get 10 + 2(10) = 30 w ords/m inute,then 30 × 60 = 1,800 w ords/hr.Y ou w ould get this inflated num ber because you added an additional 10 w ords per m inute instead of per hour.This is another reason to perform your conversions right aw ay!

33.**(D).**Since the tw o w om en are w orking together,add their rates.To find their individual rates,divide w ork by tim e.N ever divide tim e by w ork! (A lso,be careful w hen dividing the w ork by 1/2.The rate is the reciprocal of 1/2,or 2 tables/hour.)

O nce you find Jenny and Laila's com bined rate,divide the w ork required (1 table) by this rate.1 table ÷ 7/3 table/ hour = 3/7 hour.s

	W ork (tables)	=	R ate (table/hour)	×	R ate (table/hour)
Jenny	1	=	**1/3**	×	3
Laila	1	=	**2**	×	1/2
Jenny & Laila	1	=	**1/3 + 2 = 7/3**	×	3/7

34.**(A).**First,figure out the individual rate for 1 w orker: 2 violins/3 m inutes = 2/3 violin per m inute.(A lw ays divide w ork by tim e to get a rate.) N ow apply $W = RT$ separately to Q uantity A and Q uantity B .

Q uantity A :

R = 12 × the individual rate = 12 × 2/3 = 8 violins per m inute. W = 720 violins

Solve for T in $W = RT$:

$720 = 8T$
$90 = T$

Q uantity B :

R = 5 × the individual rate = 5 × 2/3 = 10/3 violins per m inute.
T = 24 m inutes

Solve for W in $W = RT$:

W= (10/3)(24)
W= 80

Since 90 > 80,Q uantity A is greater.

35.**(D).**To find K urt's w ait tim e,determ ine how long it w ill take for 200 people to board the Jelly C oaster.The problem states that 4 people board every 15 seconds.Since there are four 15-second periods in one m inute,this rate converts to 16 people/m inute.To find the tim e,divide the "w ork" (the people) by this rate.

200 people ÷ 16 people/m inute = 200/16 = 12.5 m inutes.The question asks for an approxim ation,and this is now close enough to answ er (D).In theory there m ay be an additional 15 seconds w hile K urt's group is boarding (the problem doesn't really say),but K urt's total w ait tim e w ould still be approxim ately 13 m inutes.

36.**(A).**M achine B is 50% faster than A ,so relate their rates w ith the equation $b = 1.5a$.Put the data into a chart to com pare w ork each m achine does in 24 hours.

	W ork (C D s)	=	R ate (C D s/hour)	×	Tim e (hour)
M achine A	24*a*	=	*a*	×	24
M achine B	24*b*	=	*b*	×	24

M achine B 's w ork in a 24-hour period exceeds M achine A 's w ork by 48,000 C D s.That is to say:

$36a - 24a = 48{,}000$
$12a = 48{,}000$
$a = 4{,}000$

M achine A shrink-w raps 4,000 C D s per hour.

A nother w ay to solve this problem is to notice that since B is 50% faster than A ,the quantity by w hich its w ork exceeds A 's in an hour w ill equal 50% ,or half,of A 's hourly rate.Since B shrink-w raps 48,000/24 = 2,000 m ore C D s per hour than A ,M achine A w raps 2,000 × 2 = 4,000 C D s per hour.

37.**(C).**To solve a R ates & W ork problem w ith m ultiple w orkers,m odify the standard form ula *W ork* = *Rate* × *Tim e* to this:

W ork = *Individual Rate* × *N um ber of W orkers* × *Tim e*

Solve for an individual chef's rate,using the fact that 8 chefs produce 3,200 tarts in 5 days.

W ork = *Individual Rate* × *N um ber of W orkers* × *Tim e*
3,200 tarts = (*R*)(8)(5
days) *R* = 80 tarts per day

That is,each chef can produce 80 tarts per day.Plug that rate back into the form ula for each of the quantities.

<u>Q uantity A</u>
W ork = *Individual Rate* × *N um ber of W orkers* × *Tim e*
3,600 = (80)(*N um ber of W orkers*)(3)
N um ber of W orkers = 15

<u>Q uantity B</u>
W ork = *Individual Rate* × *N um ber of W orkers* × *Tim e*
4,800 = (80)(4)(Tim
e) *Tim e* = 15 days

The num ber of chefs in Q uantity A equals the num ber of days in Q uantity B .

38.**(E).**W hen rate problem s involve m ultiple situations,it can help to set up an initial "skeleton" $W = RT$ chart for the solution.That w ay,you can easily determ ine w hat data is needed,and fill in that data as you find it.Since you w ant to know how long R obot A w ill take alone,the chart w ill look like this:

	W ork (pounds)	=	R ate (pounds/m in)	×	R ate (m in)
R obot A	165	=	A 's rate	×	*t*

Y ou know the w ork and you w ant to know the tim e,so you just need A 's rate.C all the rates *a* and *b*.N ow set up another chart representing w hat you know about the tw o robots w orking together.

	W ork (pounds)	=	R ate (pounds/m in)	×	R ate (m in)
R obot A	6*a*	=	*a*	×	6
R obot B	6*b*	=	*b*	×	6

A & B together	$6(a+b) = 88$	=	$a+b$	×	6

Now that you know that $6(a + b) = 88$, just apply the other piece of information you know: robot A's rate is 3/5 of B's rate. This can be written as $a = (3/5)b$. Since you are looking for a, substitute for b:

$a = (3/5)b$

$(5/3)a = b$

$6(a+(5/3)a) =$
$88\ 6(8/3)a = 88$
$(48/3)(a) = 88$
$a = 88(3/48)$
$a = 88(1/16) = 88/16 = 11/2$

So A's rate is 11/2 pounds per minute. Now just plug into the original chart.

	Work (pounds)	=	Rate (pounds/min)	×	Rate (min)
Robot A	165	=	11/2	×	**30**

The time Robot A takes to polish 165 pounds of gems is 165/(11/2) = 330/11 = 30 minutes.

39. **(C).** No distances are given in this problem, so you need to determine how far the two cars end up traveling before finding the distance between them. Since the cars go in the same direction, the skeleton equation is as follows:

Car A's distance - Car B's distance = distance between cars

(all distances refer to the time when car A ran out of fuel).

Since the limiting factor in this case is A's fuel supply, you must calculate how far the car is able to drive before running out of fuel. This in itself is a rate problem of sorts:

30 miles per gallon × 8 gallons = 240 miles

So Car A will end up 240 miles north of its starting point, which happens 240/40 = 6 hours after it started. What about Car B? It started an hour later and thus traveled (30 miles per hour)(6 hours - 1 hour) = 180 miles by that time.

Therefore the two cars were 240 - 150 = 90 miles apart when car A ran out of fuel.

40. **(B).** First, build a chart to see how many doubling periods occured to grow the population from 50 to 3,200. Most problems of this sort rely on converting any growth rate to a doubling period.

50
100
200

400
800
1,600
3,200

The population doubled 6 tim es in 2 days.48 hours/6 doubling periods = 8 hours per doubling period.Therefore the population doubles every 8 hours.

Q uantity A :
A fter 16 m ore hours,the population has gone through 2 doubling periods,so it has quadrupled (that is,it has increased by a factor of 4) from the final level of 3,200.Since Q uantity A is actually tw ice that population,the quantity is 8 tim es 3,200.

Q uantity B :
A fter 32 m ore hours,the population has gone through 4 doubling periods,so it has gone up by a factor of $2 \times 2 \times 2 \times 2 = 2^4 = 16$.Q uantity B is 16 tim es 3,200.

Q uantity B is greater.N otice that you don’t need to actually figure out 8 × 3,200 or 16 × 3,200.

41.**(C).**(D) is a trap.This issue is relatively rare,but it’s w orthw hile to be able to recognize it if you see it. N ote that in this case,each robot is *independently* assem bling com plete doghouses.Since the question asks for the num ber of *com pleted* doghouses after $2\frac{1}{2}$ hours,you need to rem ove any *incom plete* doghouses from the calculations.

Since one robot com pletes a doghouse in 12 m inutes,the individual hourly rate is 60/12 = 5 doghouses per hour.Therefore,each robot produces 5 × 2.5 = 12.5 doghouses in $2\frac{1}{2}$ hours.(Y ou could also sim ply divide the 150 total m inutes by 12 m inutes per doghouse to get the sam e result.)

H ow ever,since you are interested only in *com pleted* doghouses,and the robots are w orking independently,drop the decim al.Each robot com pletes only 12 doghouses in the tim e period,for a total of 12 × 10 = 120 doghouses.

42.**(B).**The question gives you the initial value and the rate of doubling,so you can set up the solution in a straightforw ard m anner.The hardest part is cutting through all the language to find w hat you need.The initial value is stated outright: 5 m illion transistors/square m m .To find the num ber of doubling periods,first convert from years to m onths:

$$\frac{30 \text{ years} \times 12 \text{ months per year}}{18 \text{ months per doubling period}} = \frac{360}{18} = 20 \text{ doubling periods}$$

So there is an initial density of 5 m illion,doubled 20 tim es.Thankfully,you don’t have to calculate that num ber! Since the answ er choices are in exponential form ,set things up that w ay.A lso,note that the question asks for the density in m illions of transistors/square m m ,so you need to use 5,rather than 5,000,000,in the calculation.5 doubled 20 tim es = 5×2^{20}

43.**(E) 10/3.**If tw ice as m any bottles of Soda V as of Soda Q are filled at the factory each day,then tw ice as m any bottles of Soda V as of Soda Q are filled at the factory each second.

U se sm art num bers for the num ber of bottles filled each second.Since tw ice as m any bottles of Soda V are produced,so the output in one second could be 100 bottles of V and 50 bottles of Soda Q .U sing these num bers, the volum e of the Q bottles is 500 liters / 50 bottles = 10 liters/bottle and the volum e of the V bottles is 300 liters/100 bottles = 3 liters/bottle.The ratio of the volum e of a bottle of Q to a bottle of V is 10 liters/3 liters = 10/3.

44.**(B).**To determ ine how long Ferris' breaks w ere,you need to know the difference betw een the am ount of w ork the tw o *should* have com pleted in tw o hours,and the am ount they actually *did* com plete (that is,one full job).

A udrey and Ferris are w orking together,so first find each w orker's individual rate,and then add them together to get the com bined rate.

	W ork (jobs)	=	R ate (jobs/hour)	×	Tim e (hours)
A udrey	1	=	**1/4**	×	4
Ferris	1	=	**1/3**	×	3
A udrey & Ferris	**7/6**	=	**1/4 + 1/3 = 3/12 + 4/12 = 7/12**	×	2

C om bining the tw o w orkers' rates,together they com plete 7/12 job per hour,so they should have com pleted 14/12 = 7/6 job in tw o hours.Therefore,Ferris' breaks cost them 7/6 - 1 = 1/6 job w orth of productivity.

H ow long w as Ferris on break? The am ount of tim e it w ould have taken him to do 1/6 of the job.

Ferris' breaks	1/6 job	=	1/3 job/hour	×	**1/2 hour**

A t the rate of 1/3 job/hour,Ferris m ust have spent 1/2 hour on break to m iss 1/6 job.Therefore,each of his 3 breaks w as 30 m inutes ÷ 3 = 10 m inutes long.The answ er is (B).

A lternatively,use sm art num bers to elim inate the fractions.D efine the job as,say,m aking 12 toys.N ow you can say that A udrey m akes 3 toys/hour and Ferris m akes 4 toys/hour.The w ork is all the sam e as above,but w hen you get to the point of figuring out Ferris' m issed tim e,the w ork becom es m uch easier.Together,the tw o should produce 14 toys,but they produced only 12.Thus,Ferris' slacking costs them 2 toys.Since his rate is 4 toys/hour,he m ust have m issed 1/2 hour of w ork (by taking 3 breaks of 10 m inutes each).

45.**(E).**To find the turtle's average speed for the trip,divide total distance by total tim e.

Since the distance has not been defined,call each equal leg of the trip *D* .Therefore,the turtle's total distance is 3*D* .(N ote that the *D* m ust cancel out before you are done.) Find the turtle's total tim e by calculating the tim e for each leg of the journey.In each case,the tim e is equal to *D* /rate.

	Distance	=	Rate	×	Time
Up	*D* miles	=	4 mi/hr	×	***D* /4 hr**
Across	*D* miles	=	*x* mi/hr	×	***D* /*x* hr**
Down	*D* miles	=	x^2 mi/hr	×	***D* /x^2 hr**

Now find the total time by adding up the separate legs, using a common denominator:

$$\frac{D}{4}+\frac{D}{x}+\frac{D}{x^2}=$$

$$\frac{Dx^2}{4x^2}+\frac{4Dx}{4x^2}+\frac{4D}{4x^2}=$$

$$\frac{Dx^2+4Dx+4D}{4x^2}=$$

$$\frac{D\left(x^2+4x+4\right)}{4x^2}$$

All that's left to do is plug this total time, along with the total distance of 3*D*, into the formula for average rate (= Total distance/Total time):

$$\frac{3D}{\frac{D\left(x^2+4x+4\right)}{4x^2}}=$$

$$\frac{3D\times 4x^2}{D\left(x^2+4x+4\right)}=$$

$$\frac{12x^2}{x^2+4x+4}$$

Notice that the *D*'s cancel out, as predicted. To match this to answer choice (E), you need to recognize the denominator as a special product: $(x + 2)^2$.

Alternatively, you can solve this problem with smart numbers. Make $x = 5$. Since $x^2 = 25$, you want a distance for each leg that is divisible by 4, 5, and 25. A distance of 100 will work nicely. Now find the time for each leg of the trip.

	Distance (miles)	=	Rate (miles/hour)	×	Time (hours)
Up	100	=	4	×	**25**
Across	100	=	$x = 5$	×	**20**
Down	100	=	$x^2 = 25$	×	**4**
Entire Trip	300	=			**49 hr**

The turtle's average rate is 300/49 mi/hr. There is no need to simplify, as you just need to plug in for x in each answer choice and see whether the result matches. When you plug $x = 5$ into the answer choices, only (E) produces 300/49.